GPDs
Flavor Separation

S. Fazio

EIC Working Group meeting

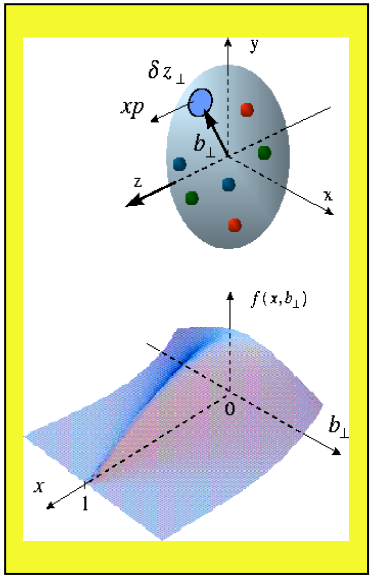
BNL – December 6th, 2017

OBSERVABLES

4 Unpol + 4 Pol GPDs

$$\frac{d\sigma}{dt} \sim A_0 \left[|H|^2 (x,t,Q^2) - \frac{t}{4M_p^2} |E^2| (x,t,Q^2) \right]$$

Dominated by H
slightly dependent on E



$$A_C = \frac{d\sigma^+ - d\sigma^-}{d\sigma^+ + d\sigma^-} \propto Re(A)$$

→ **Requires a positron beam at eRHIC**

$$A_{LU} \propto y \left[F_1(t) H(\xi,\xi,t,Q^2) - \frac{t}{4M^2} F_2(t) E(\xi,\xi,t,Q^2) + \ldots \right]$$

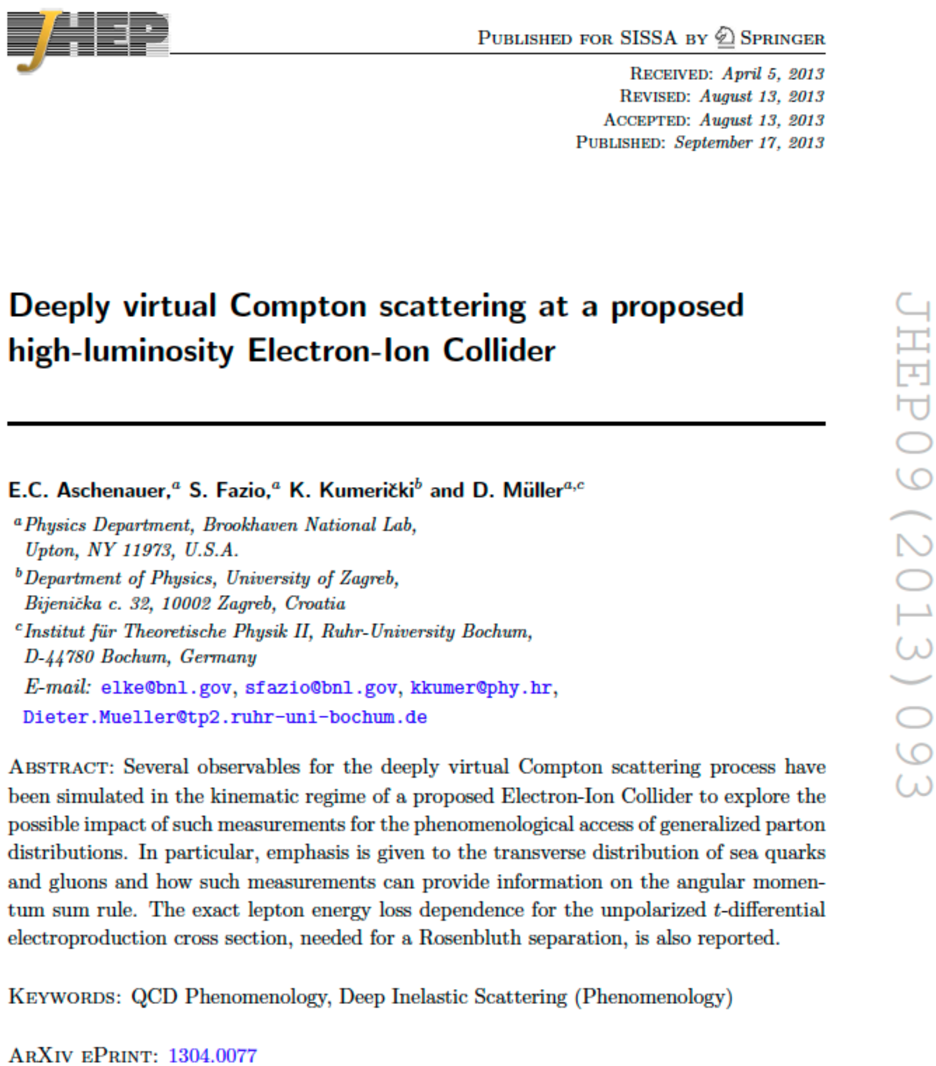
Dominated by H
slightly dependent on E

$$A_{UT} \propto \sqrt{\frac{-t}{4M^2}} \left[F_2(t) H(\xi,\xi,t,Q^2) - F_1(t) E(\xi,\xi,t,Q^2) + \ldots \right]$$

$\sin(\Phi_T - \phi_N)$
governed by E and H

Sensitive to orbital angular momentum – Ji sum rule

RECAP OF WHAT WE DID



Published for SISSA by Springer

Received: April 5, 2013
Revised: August 13, 2013
Accepted: August 13, 2013
Published: September 17, 2013

JHEP09(2013)093

Deeply virtual Compton scattering at a proposed high-luminosity Electron-Ion Collider

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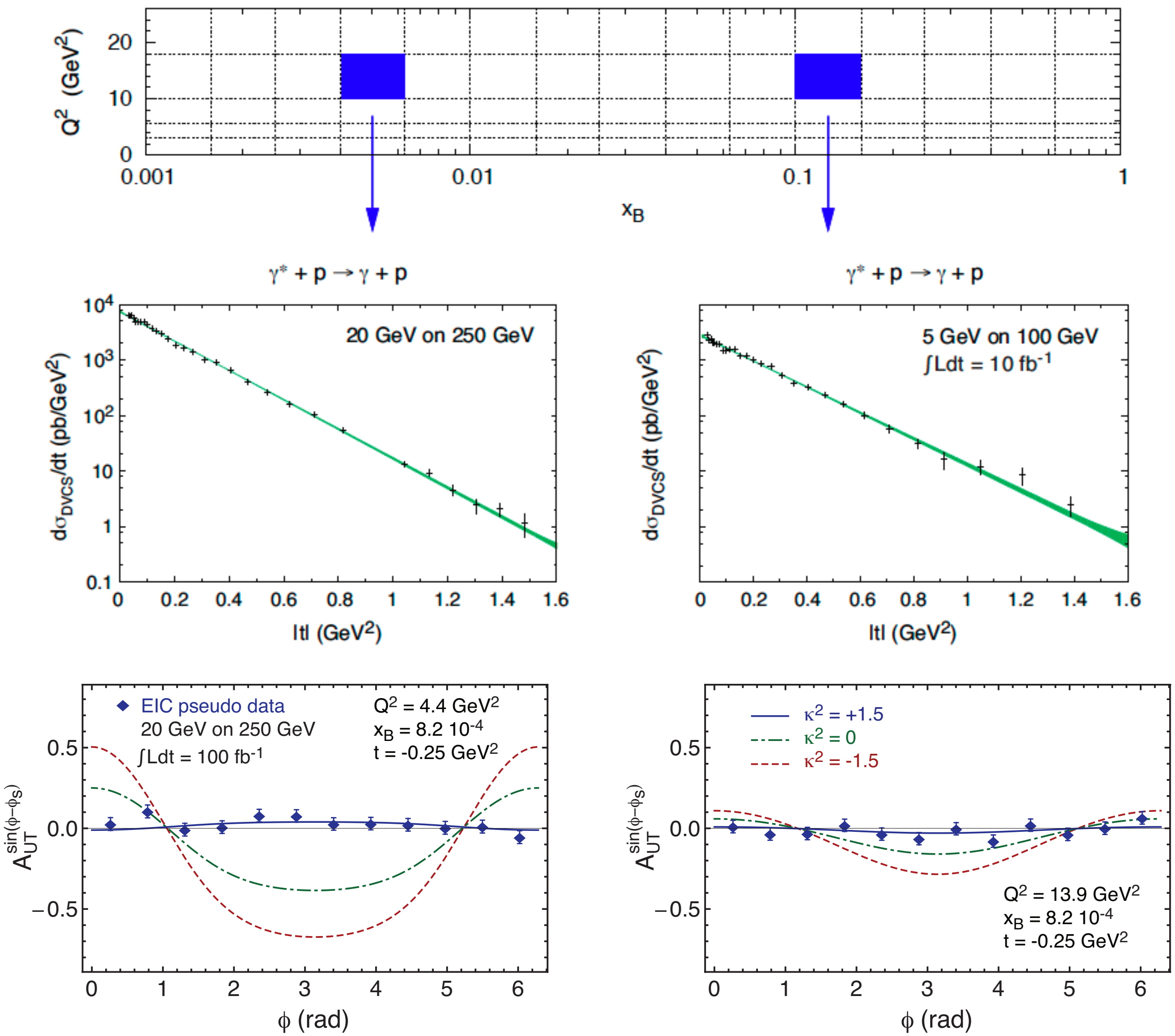
Abstract: Several observables for the deeply virtual Compton scattering process have been simulated in the kinematic regime of a proposed Electron-Ion Collider to explore the possible impact of such measurements for the phenomenological access of generalized parton distributions. In particular, emphasis is given to the transverse distribution of sea quarks and gluons and how such measurements can provide information on the angular momentum sum rule. The exact lepton energy loss dependence for the unpolarized t-differential electroproduction cross section, needed for a Rosenbluth separation, is also reported.

Keywords: QCD Phenomenology, Deep Inelastic Scattering (Phenomenology)

ArXiv ePrint: 1304.0077

DVCS differential cross section



Luminosity:
~10 fb^{-1} [1 year @ 5x100]
~100 fb^{-1} [1 year @ 20x250]

- ✧ **EIC will provide sufficient lumi to bin in multi-dimensions**
- ✧ **wide x and Q^2 range needed to extract GPDs**

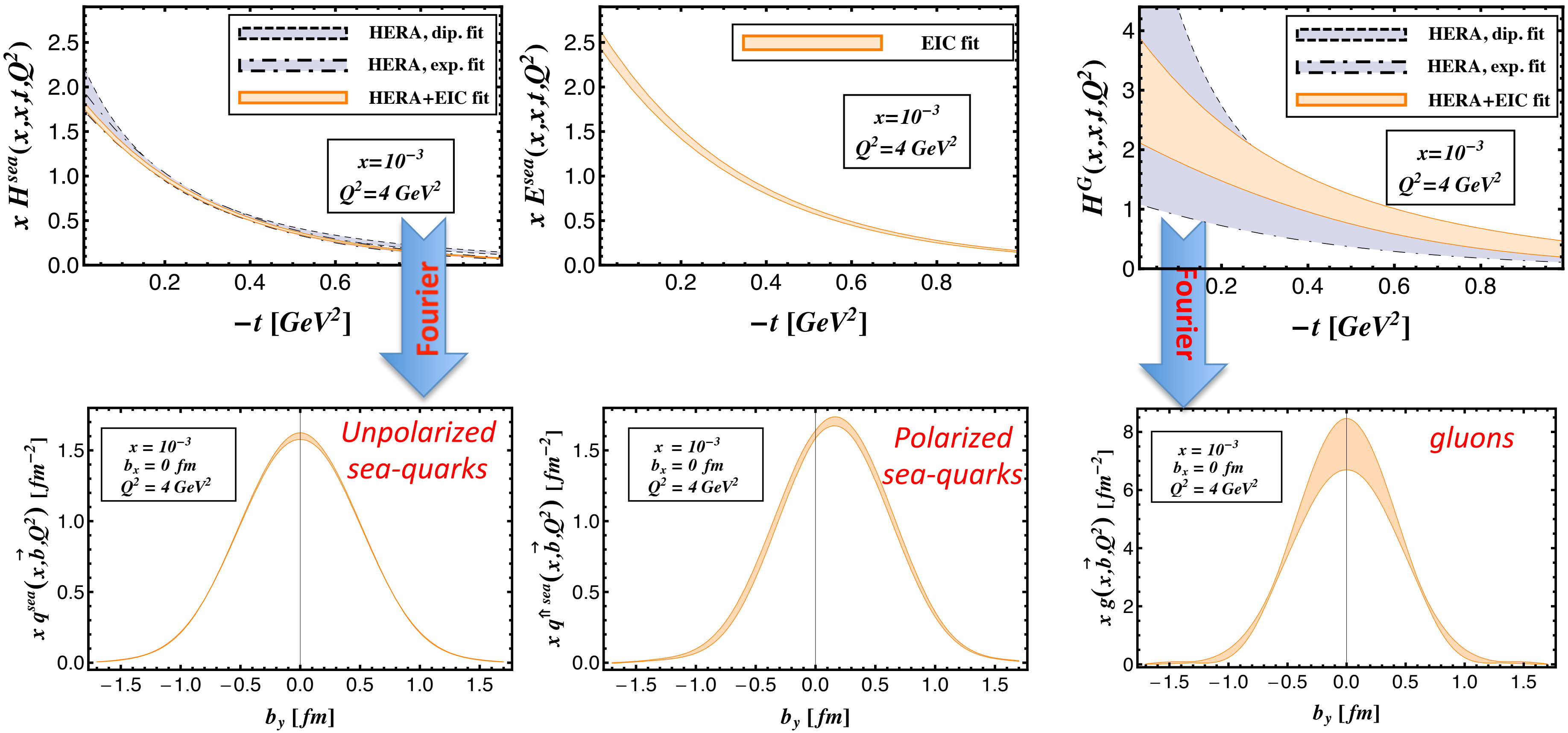
Simulation:

- y>0.01 (detector acceptance)
- Detector smearing
- The |t|-binning is (3*reso)
- Exponential |t|-dependence exp(B*|t|)
- B-slope=5.6 compatible with H1 data, to facilitate Dieter's global fitting
- 5% systematic uncertainties

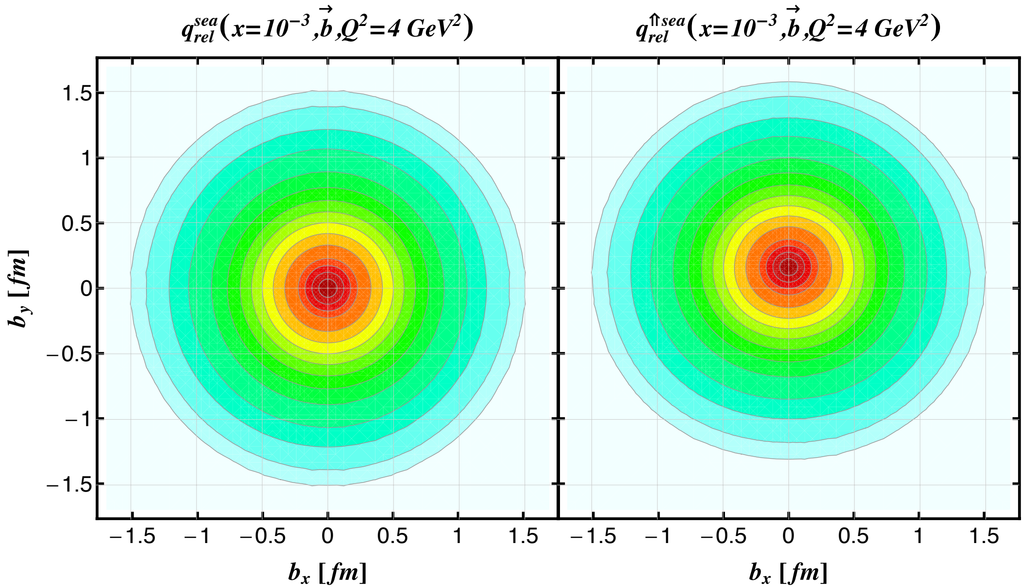
DVCS-based imaging

➢ **A global fit over all mock data was done, based on the GPDs-based model:**
[K. Kumerički, D. Müller, K. Passek-Kumerički 2007]

$$q\left(x,\vec{b},\mu^2\right) = \frac{1}{4\pi}\int_0^\infty d|t|\,J_0\left(|\vec{b}|\sqrt{|t|}\right)H\left(x,\eta=0,t,\mu^2\right)$$



The nice White Paper picture on imaging



Impact of DVCS @ EIC:

✓ **Excellent reconstruction of *H^{sea}*, and *H^g* (from *$d\sigma/dt$*)**

✓ **Reconstruction of GPD E (connection to the orbital momentum Ji-sum role)**

All this is purely based on **DVCS in e+p alone** → it's nice but only part of the story

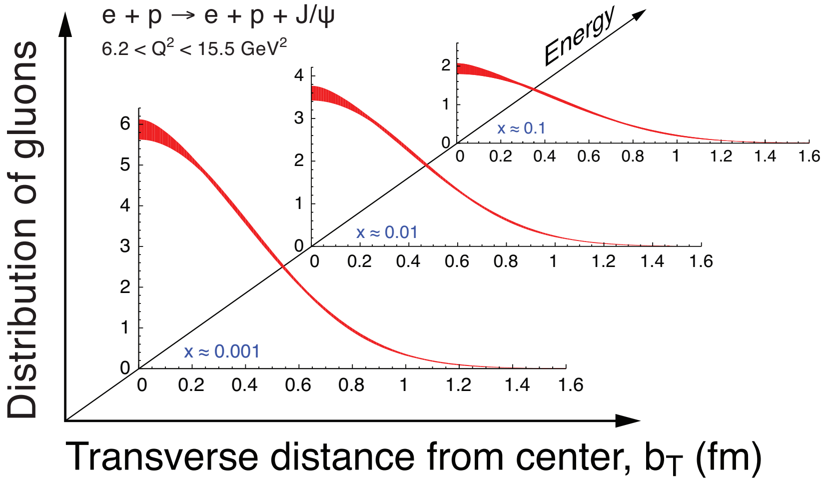
What is still missing?

- GPD H-Gluon is nice but can be much better
- Access to GPD E-gluon → orbital momentum (Ji sum rule)
- Flavor Separation of GPDs
- Nuclear imaging

How to separate flavors?

Method 1 – VMP

rho0: 2u+d 9/4g
omega: 2u-d /4g
phi: s,g
rho+: u-d
J/psi: g



We simulated the J/Psi cross section and the Fourier transform but never included it on GPDs fits

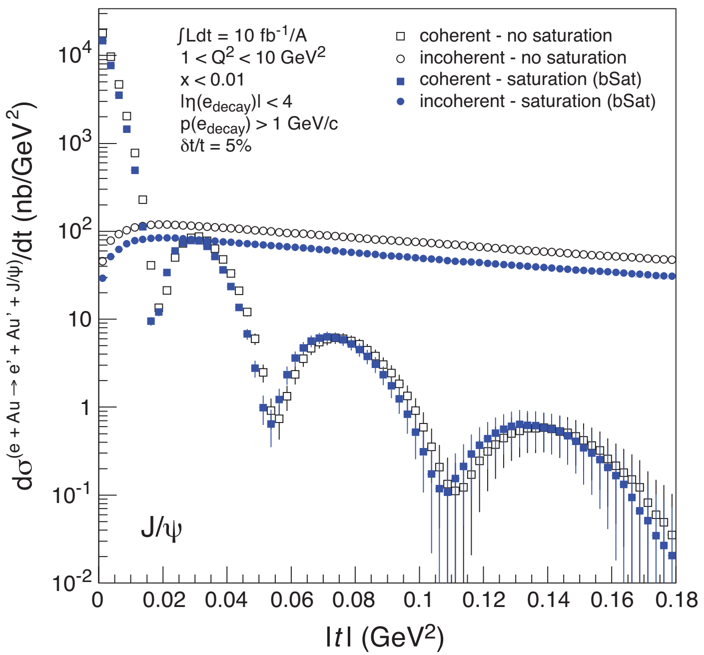
Challenges of VMP (if compared to DVCS)

- Uncertainty on wave function
- measuring muons vs electron decay channel

Method 2 – DVCS on protons and neutrons

- **We do not a real neutron target → Use Deuterium (D)**
- **We incoherent DVCS on D (D can break up) but coherent on n (tagged on ZDC)**
- **Separates u and d quarks – less statistics and higher experimental complications**
- **One still needs J/psi for precisely accessing the gluons and extract Eg**

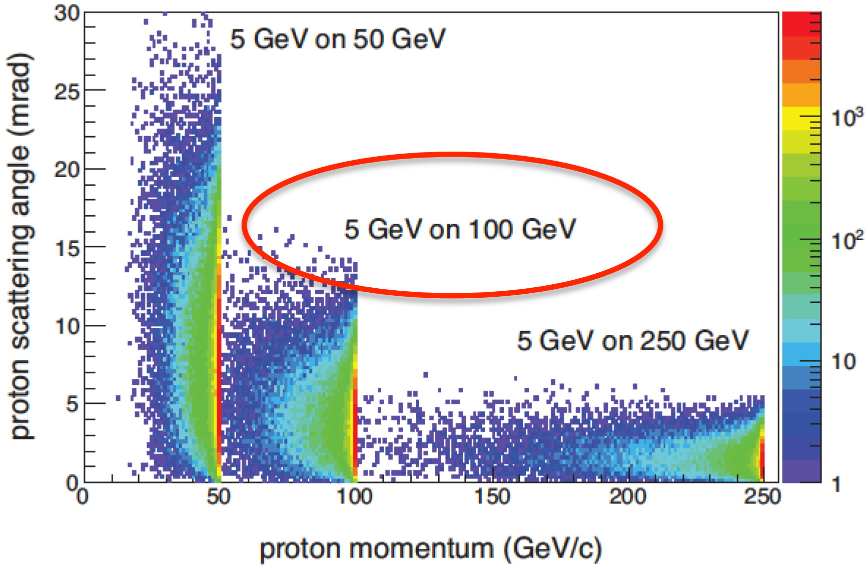
Imaging the gluons in nuclei



Same for e+p
nuclear GPDs ≠ free proton GPDs
Can we think of quantifying an impact for EIC?

- ✓ A lot still left open for a crucial physics topic that can potentially impact decisions on machine and detectors
- ✓ Our colleagues in Croatia seam ready for a global fit of VMPs, need to verify with them
- ✓ Potential impact of flavor separation quark and gluon imaging in understanding confinement still to be quantified

Side note



- Proton momentum acceptance driven by proton beam energy

5x100 → **√s=45GeV**

A proton energy of 100 GeV already covers the phase space for DVCS up to the region of JLAB12 measurements!

→ Why do you need a huge D0 magnet motivating it as essential for DVCS and exclusive processes?